rays to become photographic rays. Some eight years ago it was my own good fortune to make the dark infra-red rays impress themselves on a plate. This last has been too much a specialty of my own, although full explanations have been given of the methods employed. By preparing a bromide-of-silver salt in a peculiar manner, one is able so to modify the molecular arrangement of the atoms that they answer to the swings of those waves which give rise to these radiations. By employing this salt of silver in a film of collodion or gelatine, the invisible part of the spectrum can be photographed, and the images of bodies which are heated to less than red heat may be caused to impress themselves upon the sensitive plate. The greatest wave-length of the spectrum to which this salt is sensitive, so far, is 22,000 $\lambda$, or five times the length of the visible spectrum. The exposure for such a wave-length is very prolonged; but down to a wave-length of 12,000 it is comparatively short, though not so short as that required for the blue rays to impress themselves on a collodion plate. The color of the sensitive salt is a green-blue by transmitted light. It has yet to be determined whether this color is all due to the coarseness of the particles, or to the absorption by the molecules. The fact that a film can be prepared which by transmitted light is yellow, and which may be indicative of color due to fine particles, together with an absorption of the red and orange, points to the green color being probably due to absorption by the molecules. We have thus in photography a means of recording phenomena in the spectrum from the ultra-violet to a very large wave-length in the infra-red, — a power which physicists may some day turn to account. It would, for instance, be a research worth pursuing to photograph the heavens on a plate prepared with such a salt, and search for stars which are nearly dead or newly born; for in both cases the temperature at which they are may be such as to render them below red-heat, and therefore invisible to the eye in the telescope. It would be a supplementary work to that being carried out by the brothers Henri, Common, Roberts, Gill, and others, who are busy securing photographic charts of the heavens in a manner which is beyond praise.

There is one other recent advance which has been made in scientific photography to which I may be permitted to allude; viz., that, from being merely a qualitative recorder of the action of light, it can now be used for quantitative measurement. I am not now alluding to photographic actinometers, such as have been brought to such a state of perfection by Roscoe, but what I allude to is the measurement and interpretation of the density of deposit in a negative. By making exposures of different lengths to a standard light, or to different known intensities of light, on the same plate on which a negative has to be taken, the photographic values of the light acting to produce the densities on the different parts of the developed image can be readily found. Indeed, by making only two different exposures to the same light, or two exposures to two different intensities of light, and applying the law of density of deposit in regard to them, a curve is readily made from which the intensities of light necessary to give the different densities of deposit in the image impressed on the same plate can be read off. The application of such scales of density to astronomical photographs, for example, cannot but be of the highest interest, and will render the records so made many times more valuable than they have hitherto been. I am informed that the United States astronomers have already adopted the use of such scales, which for the last three years I have advocated, and it may be expected that we shall have results from such scaled photographs which will give us information which would before have been scarcely hoped for.

One word as to a problem which we may say is as yet only qualitatively and not quantitatively solved. I refer to the interchangeability of length of exposure for intensity of light. Put it in this way. Suppose that with a strong light, $L$, a short exposure, $E$, being given, a chemical change, $C$, is obtained: will the same change, $C$, be obtained if the time is only an $n$th of the light, $L$, but $n$ times the exposure? Now, this is a very important point, more particularly when the body acted upon is fairly stable; as, for instance, some of the water-color pigments, which are known to fade in sunshine, but might not be supposed to do so in the light of an ordinary room, even with prolonged exposure. Many experiments have been made at South Kensington as regards this, more especially with the salts of silver; and it is found, that, for any ordinary light, intensity and exposure are interchangeable, but that when the intensity of light is very feeble, say the $\frac{1}{1000000}$ of ordinary daylight, the exposure has to be rather more prolonged than it should be supposing the exact interchangeability always held good. But it has never been found that a light was so feeble that no action could take place. Of course, it must be borne in mind that the stability of the substance acted upon may have some effect; but the same results were obtained with matter which is vastly more stable than the ordinary silver salts. It may be said, in truth, that almost all matter which is not elemental is in time, and to some degree, acted upon by light.

I should like to have said something regarding the action of light on the iron and chromium salts, and so introduced the subject of platinotype and carbon printing, the former of which is creating a revolution in the production of artistic prints. I have, however, refrained from so doing, as I felt that the president of Section A should not be mistaken as the president of Section B. Photogravure and the kindred processes were also inviting subjects on which to dwell, more especially as at least one of them is based on the use of the same material as that on which the first camera picture was taken by Niépce. Again, a dread of trenching on the domains of art restrains me.

Indeed, it would have been almost impossible, and certainly impolitic, in the time which an address should occupy, to have entered into the many branches of science and art which photography covers. I have tried to confine myself to some few advances that have been made in its theory and practice.

The discovery of the action of light on silver salts is one of the marvels of this century, and it is difficult to overrate the bearing it has had on the progress of science, more especially physical science. The discovery of telegraphy took place in the present reign, and two years later photography was practically introduced; and no two discoveries have had a more marked influence on mankind. Telegraphy, however, has had an advantage over photography in the scientific progress that it has made, in that electrical currents are subject to exact measurement, and that empiricism has no place with it. Photography, on the other hand, has labored under the disadvantage, that, though it is subject to measurement, the factors of exactitude have been hitherto absent. In photography we have to deal with molecules the equilibrium of whose components is more or less indifferent according to the process used. Again, the light employed is such a varying factor that it is difficult to compare results. Perhaps more than any other disadvantage it labors under, is that due to quackery of the worst description at the hands of some of its followers, who not only are self-asserting, but often ignorant of the very first principles of scientific investigation. Photography deserves to have followers of the highest scientific calibre; and, if only some few more real physicists and chemists could be induced to unbend their minds and study the theory of an applied science which they often use for record or for pleasure, we might hope for some greater advance than has hitherto been possible.

Photography has been called the handmaid of art: I venture to think it is even more so the handmaid of science, and each step taken in perfecting it will render it more worthy of such a title.

## ELECTRICAL NEWS.

### Recent Fatalities from Electricity.

ONE death and several serious injuries from electric-light wires have occurred during the past two weeks. Some days ago the eight-year-old son of Charles Kern of Baltimore came in contact with an electric-light wire while looking out of a window, lost his balance, and fell to the street. A New York daily newspaper, alluding to the fact, stated that the boy was "fairly lifted out of the room, and hurled into the street;" all of which is interesting, if true. John Powers, an employee of The Brush Electric-Light Company, thoughtlessly took hold of a live wire with one hand, and with the other made an excellent ground connection with the Elevated Railroad structure on East 34th Street. He was standing on a step-ladder at the time; and the shock of the fall, not the current, killed him. Some days after this occurrence a poor vagrant,

while standing on a curbstone, was struck a light tap by a coil of dead wire which a lineman dropped from a telegraph-pole. After considering the subject for some minutes, he concluded he had received a dangerous electric shock, and communicated the fact to the lineman and various passers-by. A medical examination showed no injuries from electricity.

With regard to these accidents, which as a rule receive sensational and exaggerated notice in the daily papers, it should not be forgotten that two connections with the body are always necessary for an electric shock; the "deadly wire" being of course one, while the other is the damp surface of the sidewalk, ground, a wet telegraph-pole, or other conductor. A person touching a live wire with no other electrical connection would feel nothing; neither would there be any perceptible shock should he stand upon dry boards or other insulated or insulating material.

Another thing to be borne in mind is that writers of sensational articles regarding electrical accidents, like all reporters, make up two or three columns of such matter more with regard to interest than accuracy, for the reason that the managing editor of the paper in which they appear will receive them, and the writers will be rewarded at the rate of from four to eight dollars per column for their work.

According to one of these articles in a New York daily, Mayor Grant is said to believe that the only way wholly to prevent accidents of this kind is by burying the wires, and that, when this shall be done, "there will be no more deaths resulting from people coming accidentally in contact with electric currents of sufficient force to render medical assistance useless." No doubt, many of the accidents already reported would never have occurred had the wires been under ground; but, as ex-Mayor Hewitt said before the National Electric-Light Association in 1888, "Gentlemen, when you once have your wires under ground, the next thing is to get them out for use."

Arc-lighting has evidently come to stay, and wherever the arc-light is, there its connections must be more or less exposed. The experiments of the ignorant, and the carlessness of reckless linemen, will continue to result in casualties as long as arc-lights are used, whether the wires are buried or not.

FUTURE RAPID-TRANSIT FOR MAIL AND EXPRESS MATTER. — There are at present two systems before the public for the rapid transit of mail and other light matter, either or both of which will no doubt prove successful in the near future. The Weems system, an experimental track for which has been built at Laurel, Md., has been illustrated and described at length in *Science;* and the results from the small experimental section already equipped have seemed to justify the construction of a five-mile track, which will soon be completed. This system employs actual electric motors in connection with a light elevated structure, the weight of the car with the motors being something like three tons. Whether such a mass, with its complicated and delicate electrical machinery, will come finally into commercial use, remains to be seen. The other system referred to is known as the Portelectric system, and the motto of the inventor is, "To dispense with mass and machinery." In this system a number of helices are used, taking their current from a metallic circuit on an elevated structure. The car itself is nothing more than a magnetized steel cylinder, pointed at both ends, running on a single track. The mail or other matter is placed in this receptacle, and the successive attractions of the different helices through which it passes augment its speed to a velocity the limit of which is so far unknown. A small section has been on exhibition for some time past in the Old South Church, Boston, and thousands of visitors have witnessed the phenomenal speed of the light steel cylinder, even in the narrow confines of the church. The New England Portelectric Company is now building a demonstrative section on a similar principle in Dorchester district, Boston, Mass., and the results will be looked forward to with interest. The electrical pressure used will be somewhere between two hundred and one thousand volts. The track will be elliptical, and the curves laid at an angle which will justify a speed of at least three miles per minute. The material is now on the ground, and the work is to be pushed rapidly forward. The inventor, Mr. John T. Williams of New York, is considering the extension of this principle to the projection of dynamite cartridges.

THE EIFFEL TOWER AND LIGHTNING. — It has been claimed from the first that the conductivity of the Eiffel Tower is sufficient not only to protect it against lightning, but to protect a large area contiguous to it. It is now claimed that the tower and some of its occupants have recently suffered from a stroke of lightning, and various accounts of "blue flames playing about the structure" have been current in the public press. These reports would be almost incredible, were it not for the fact that the directors have taken cognizance of the matter, and are seriously considering whether the conductivity of the tower is sufficient as it now stands. The safety of the structure is of considerable moment, not only to visitors, but from a financial point of view, when it is considered that a recent week's receipts, exclusive of rentals and privileges, have amounted to the round sum of sixty-seven thousand dollars.

## BOOK-REVIEWS.

*Institutes of Economics.* By E. BENJAMIN ANDREWS. Boston, Silver, Burdett, & Co. 12°.

THIS book has been written because the author thinks that the existing manuals on the subject involve two serious faults of method. One is that they explain every thing too fully, thus leaving too little for teacher and student to do; and the other is that they do not mark by difference of type the distinction between the principles of the science and the examples used to illustrate them. Accordingly, his own presentation of the subject is very succinct, so much so as to deprive his book of all literary form; and his illustrations and much other matter are given in the form of notes. We are strongly of opinion that in both respects he has made a mistake. Economics is too difficult a subject to be adequately taught in so succinct a form as that of this treatise; and the separation of principle and illustration, besides being a literary fault, increases the difficulty of understanding the science. However, nothing but actual use can determine the merits of Mr. Andrews's method, and his work certainly contains a large amount of matter, and shows a thorough mastery of the best works on the subject. His views are substantially those of the English writers, with some modifications due to German thought. The concise character of the work renders some of its expositions obscure, and insufficient for a proper understanding of the subject, this being particularly the case with the account of supply and demand, which is only presented in a note, and very insufficiently there. The author's views are in the main sound, but his theory of "ideal money" can hardly be called so. He would have the State issue all money, both coin and paper; and, when there occurred a general fall or rise of prices, the government should "correct the same by expanding or contracting the circulation." Let us hope that "ideal money" will never come into use.

*Handbook of Psychology. Senses and Intellect.* By JAMES MARK BALDWIN. New York, Holt. 8°.

THIS volume is the first part of a general treatise on psychology, the second volume being designed to treat of the emotions and the will. It is both descriptive and theoretical, and is intended to present the latest views on the science, so far as these are accepted by the author. The style is plain and easily understood, except in a few places where the writer does not seem to have a perfect mastery of the thought he wishes to convey. Professor Baldwin considers the introspective method as the main instrument of psychological study, though he recognizes the value of the experimental method, so far as its reach extends. He rejects the theory of unconscious intelligence, and gives good reasons for doing so. His discussion of consciousness and of the nature and methods of psychology are among the best portions of the work. His views are to a certain extent eclectic, and reflect the present unsettled state of both psychology and philosophy. He tells us that he studied philosophy under one of the leaders of the Scottish school, and his work reflects in many respects the influence of that school. His classification is similar to theirs, and in particular he follows them in his treatment of reason as the "regulative faculty," the faculty of intuitions. In other parts his work shows the influence of Kant, while that of the empirical school and the physiologists is also apparent. Take, for example, his theory of the perception of